HANSEN

Design of a Modern Brick Plant

Civil Engineering

B. S.

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DESIGN OF
A MODERN BRICK PLANT

BY

MERRITT RASMUS HANSEN

THESIS

FOR

DEGREE OF BACHELOR OF SCIENCE

IN

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I recommend that the thesis prepared under my supervision by MERRITT RASMUS HANSEN entitled Design of a Modern Brick Plant be approved as fulfilling this part of the requirements for the degree of Bachelor of Science in Civil Engineering.

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Recommendation approved

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INTRODUCTION

The enormous demand for bricks in modern construction has stimulated the invention of many types of machinery and of building design, both to save labor and to produce quickly large quantities of moulded brick from crude clay. This thesis will treat of the design of a plant having a construction which will develop a high efficiency. A short description will first be given of two existing plants in Illinois.

DESCRIPTION OF TWO BRICK PLANTS IN ILLINOIS

The Barr Brick Company

The Barr Brick Company of Urbana, Illinois, produces a grade of machine-moulded, pressed brick which commands a good price. The methods of production, however, are inefficient. The bricks are conveyed to the dryers on wheelbarrows and are then placed in drying sheds which expose them to the wind and weather. By this method of drying, which in itself is a slow process, the bricks are liable to be damaged by sudden storms. The corners are washed off and the surfaces roughened, thus producing a very undesirable brick. The necessary handling in transferring the brick from the wheelbarrow to the dryers and from the drying shelves to the wheelbarrow and thence to the kiln damages them

considerably. Not only is damage incurred, but a large expenditure of labor is required, and the cost of the bricks is materially increased.

The kiln-sheds are wooden structures of roughly-hewn tree-trunks, and although crude, seem to sufficiently protect the kilns from the weather. They do not, however, appear capable of withstanding a very hard windstorm. The fuel used for burning consists of various grades of coal, thus necessitating the building of fireplaces. The main objection to the use of coal is the time consumed in getting the fireplace ready and in starting fires.

The Western Brick Company

The Western Brick Company, which is located near the Illinois Traction System, just west of Danville, is a very large plant, having fifty-seven "bee-hive" kilns. The "science of brick making" has been utilized in the building of this plant. Advantage is also taken of the natural resources at hand. The clay is a very hard, stiff shale and consists of a vein about thirty feet thick, covered with from eight to ten feet of sand. Directly below the shale lies a vein of coal which varies from six to seven feet in thickness. This is mined and is used for burning the brick and for producing power.

Both compressive and expressive machines are used in this plant, thus producing two kinds of brick,

The dryers consist of one continuous shed, through which the tracks are laid, so that the bricks may be conveyed through them on trucks. These trucks enable one man to push about seven hundred bricks at a time. The dryers are heated by waste heat,drawn off from the "bee-hive" kilns. Trials of waste-heat drying, however, have resulted in the discovery by users that its seeming advantage in economy of fuel is heavily offset by the inferior quality of the dried product.

THIS DESIGN—THE KENWOOD BRICK PLANT

Location

The Kenwood Plant is located at Jefferson, Illinois, directly upon the outskirts of Chicago. This location was chosen because Chicago and the surrounding country is built upon a fair grade of blue clay, thus making it comparatively an easy matter to obtain land from which surface clay could be removed. Not only has the ease of acquiring clay for the making of common brick been taken into consideration in determining the location, but the facility with which the brick may reach the consumer has been duly considered.

In 1912 building operations in Chicago called for approximately one and one-quarter billion of common brick, which shows that plants operated under the most modern conditions will have little trouble in disposing of their product.

The Boiler Room

The boiler room was made 60 feet wide and 150 feet long, so as to amply house the required boiler horse-power and necessary engines. The walls are built of common brick. Masonry pillars, 18x24 inches, were constructed in the walls to act as supports for the roof trusses, which are of the eight-panel Fink type. The roof covering consists of Ludowici tile laid directly upon the purlins. The stress diagram for a transverse bent is shown in Plate I, and a table of stresses is shown in Table I. The floor was made of 1:2:4 concrete, six inches thick, a pit being provided for the fly-wheel of the steam engine.

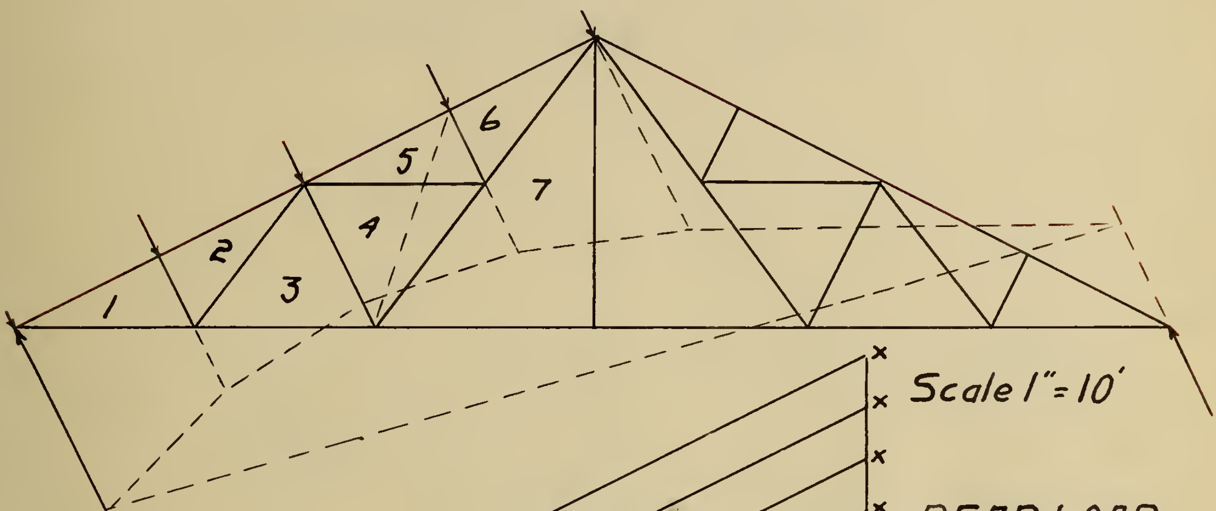
The Machine Room

The machine room is 80 feet wide and 100 feet long, and was constructed in the same manner as the boiler room. A stress diagram of a transverse bent is shown in Plate II, and a table of stresses is shown in Table II. No covering was placed on the floor, as it might be necessary to move the machinery from time to time, and this would necessitate the removal of a part of any floor previously laid.

The Dryers

Air does not absorb moisture. Absorption means taken up by or held by, and air neither takes up nor holds moisture. The part air plays in drying is

BOILER-ROOM TRUSS.



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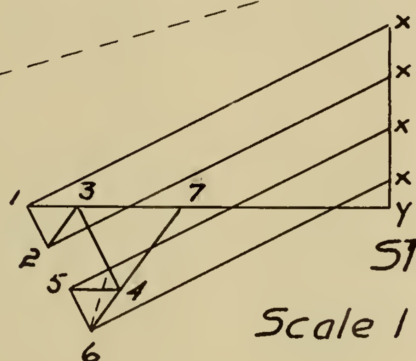
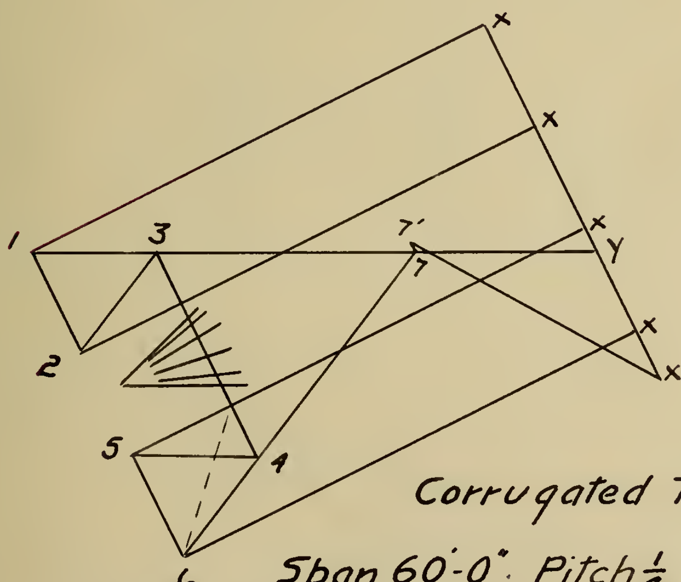


DEAD LOAD
STRESS DIAGRAM
Scale 1" = 6000#



WIND LOAD
STRESS DIAGRAM.
Scale 1" = 6000#

Corrugated Tile Roofing

Span 60'-0". Pitch $\frac{1}{4}$. Distance between Spans 18'

Panel Dead Load at 12# per sq. ft. hor. proj = 1620#

Panel Wind Load at 23# per sq. ft. of roof surface = 3470#

Minimum Snow Load at 10# per sq. ft. hor. proj.

Maximum Snow Load at 20# per sq. ft. hor. proj.

PLATE I

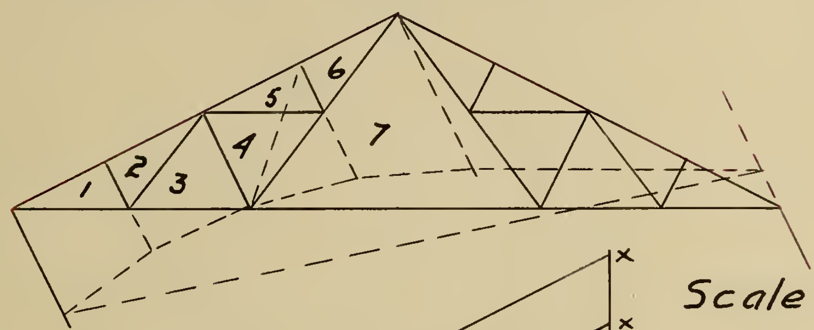
TABLE OF STRESSES

BOILER-ROOM TRUSS

Truss Member	Dead Load Stress	Snow Load Stress		Wind Load Stress	Max. Stress
		Min.	Max.		
X-I	-I2800	-I0700	-2I400	-I5800	-39300
X-2	-I2I00	-I0I00	-20200	-I5800	-38000
X-5	-II300	- 9400	-I8800	-I5800	-36500
X-6	-I0600	- 8850	-I7700	-I5800	-35250
X(6'-I')				- 8600	
Y-I	+II400	+ 9500	+I9000	+I7700	+38600
Y-3	+ 9800	+ 8I80	+I6360	+I3800	+3I800
Y-7	+ 6600	+ 5500	+II000	+ 6I00	+I8200
Y(7'-I')				+ 6I00	
I-2	-I500	- I250	- 2500	- 3500	- 6250
2-3	+ I600	+ I330	+ 2660	+ 3900	+ 6800
3-4	-2900	- 2400	- 4800	- 7000	-I2300
4-5	+ I600	+ I330	+ 2660	+ 3900	+ 6800
5-6	-I500	- I250	- 2500	-3500	- 6250

TABLE I

MACHINE-ROOM TRUSS



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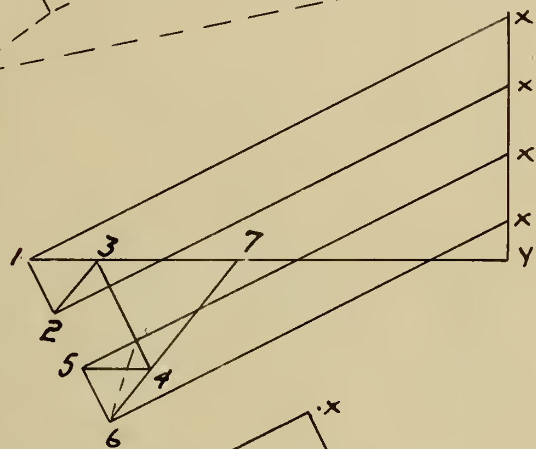
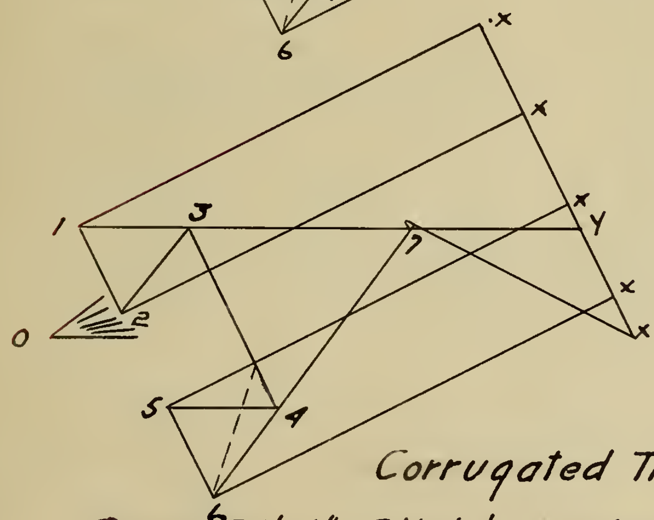


DEADLOAD
STRESS DIAGRAM
Scale 1" = 6000#



WIND LOAD
STRESS DIAGRAM.
Scale 1" = 10000#

Corrugated Tile Roofing.

Span 80'-0" Pitch $\frac{1}{4}$ Distance between Spans 20'

Panel Dead Load at 12# per sq. ft. hor. proj. = 2400#

Panel Wind Load at 23# per sq. ft. of roof surface = 5140#

Minimum Snow Load at 10# per sq. ft. hor. proj.

Maximum Snow Load at 20# per sq. ft. hor. proj.

PLATE II

TABLE OF STRESSES

MACHINE-ROOM TRUSS

Truss Member	Dead Load Stress	Snow Load Stress Min.	Snow Load Stress Max.	Wind Load Stress	Max. Stress
X-1	-19000	-15800	-31700	-23400	-58300
X-2	-17900	-14900	-30000	-23400	-56300
X-5	-16750	-13900	-27800	-23400	-54000
X-6	-15700	-13100	-26200	-23400	-52200
X(6'-1')				-12750	
Y-1	+16900	+14100	+28200	+26200	+57200
Y-3	+14550	+12100	+24200	+20400	+47200
Y-7	+ 9780	+ 8150	+16300	+ 9050	+27000
Y(7'-1')				+ 9050	
1-2	- 2200	- 1850	- 3700	- 5180	- 9250
2-3	+ 2400	+ 1970	+ 3940	+ 5780	+ 10100
3-4	- 4300	--3560	- 7100	-10400	- 18200
4-5	+ 2400	+ 1970	+ 3940	+5780	+ 10100
5-6	- 2400	- 1850	- 3700	-5180	- 9250

TABLE II

purely mechanical, but very important. With air we create drafts and sweep away the vapor as fast as it is taken up by "space." As the temperature rises, the "vapor tension" increases; therefore if we heat the air in some way, the power of air as a conveyer will be greatly increased.

The exhaust steam from the engines and also a small amount of live steam were used in the Kenwood dryers to heat the air. This steam was sent through steam pipes which were manufactured by the Standard Brick Dryer Company. The accompanying sketch gives an idea of the method employed. (See Fig.1) This diagram shows the pipes laid down for four dryer-tracks.

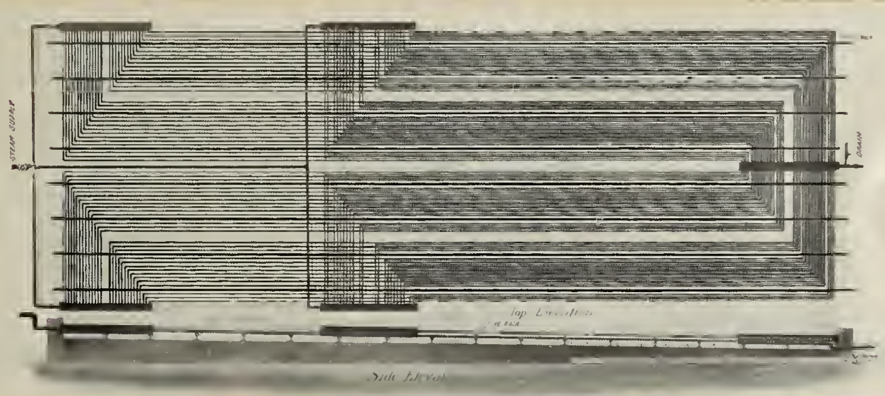


Fig.1

On entering the receiving end of the dryer-tunnel, the green product is enveloped by a body of steam-heated air, charged with moisture which is collected from the loaded cars. The moisture in the air serves to keep the surface pores of the soft clay open, while the heat begins to draw the moisture from the heart of

the product. As the car proceeds through the tunnel the process of drying continues outwardly, until every brick is thoroughly dried from center to surface.

The draft is obtained by two large stacks located at the receiving end of each dryer. (See Fig.2)

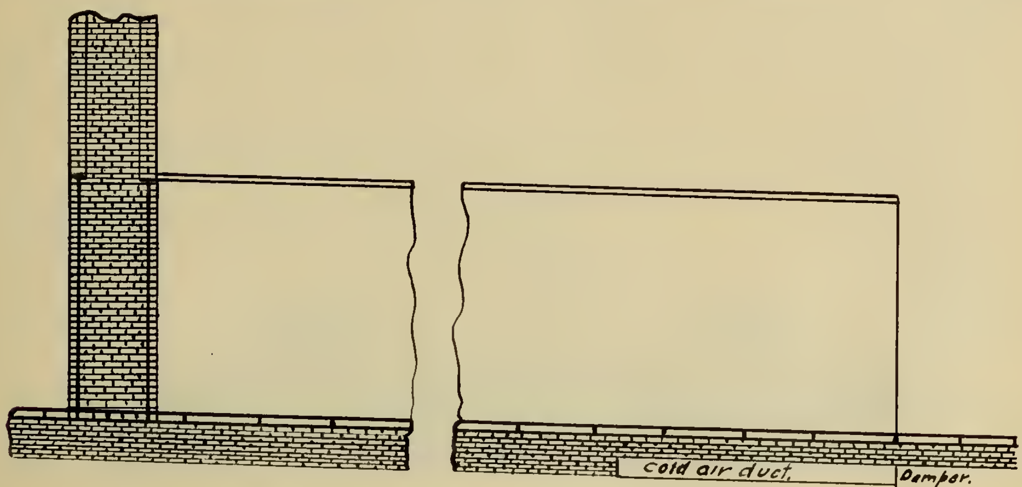


Fig. 2

The natural-draft system has been used in preference to the mechanical-draft system, because of the extreme simplicity and small expense of the former. Again, it is very easily controlled and there is no complicated machinery to get out of order. Its drying process is so nearly automatic that it is very easily operated.

The walls of the dryers are built of common brick. The roof consists of two inches of pine sheeting, covered with 3-ply granite paper, the whole being supported at ten-foot intervals by pipe columns, which rest on the steel cross-ties and are secured to them by iron clamps. The columns are shown in the general

plan. (See SHEET I.). Each dryer was made 154 feet long, inside measurement, so as to accommodate twenty cars, which are each 92 inches over all. (A description of the cars used will be given under the heading "Rolling Stock.")

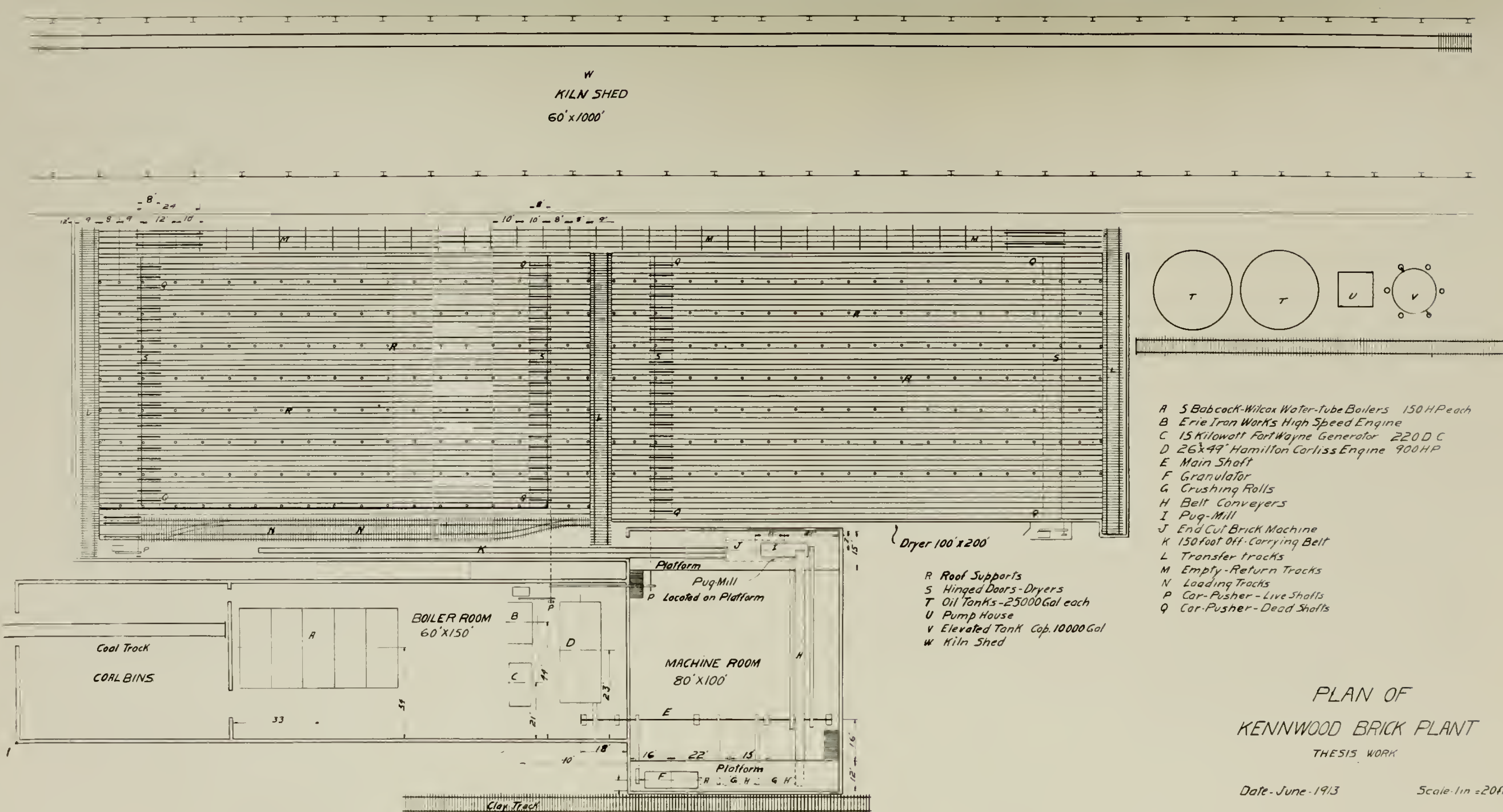
The width of each tunnel is exactly 4 feet. The tracks, 25 in number and 22½-inch gauge, are held in alignment by iron rail-chairs, firmly secured to steel cross-ties. (See Fig.3.)

Fig. 3

A slight incline was given to the tracks toward the discharge end, to facilitate the movement of the loaded cars. An extension of 16 feet at the receiving end and 17 feet at the discharging end was provided for the handling of laden cars. (See SHEET I.)

Car pushers were installed at both ends of the dryers. Each track is provided with one of these automatic pushers, somewhat similar to the one shown in Fig. 4.

The pusher proper is eight feet long, projecting through the floor 1 foot in front of the dryer door and running back into the dryer 7 feet. It consists of a chain with extended pieces of iron, which, when the



PLAN OF

KENNWOOD BRICK PLANT

THESIS WORK

Date - June - 1913 Scale - 1in = 20ft.

Drawn by - Hansen M.R. SHEET No. I

Fig. 4.

chain is running, catch the axles of the dryer car and shove it forward into the dryer, together with the entire line of cars ahead--twenty in all. The chains are driven by a live shaft P(SHEET I) , which in turn is driven by a small motor. The motor is controlled by the man on the transfer car. This method saves labor, time, and also avoids waste, for the pushing is gradual and does not jolt any of the green ware off of the cars into the tunnel.

Kiln-Shed

The general dimensions of the kiln-shed are 60 feet by 1008 feet. The trusses, which are of the Fink type with Monitor ventilator, are spaced 18 feet apart.

The trusses were designed for dead, snow, and wind loads. The dead load consists of the weight of the trusses, roof covering, and purlins. The wind load was considered as acting normal to the roof and equal to the normal component of 30 pounds per

square foot. The "straight line" formula was used to obtain the normal component of the wind. The minimum snow load was taken at 10 pounds per square foot of horizontal projection, and the maximum snow load at 20 pounds per square foot of horizontal projection.

The stresses were all determined by graphic methods. (See SHEET 2.) For determination of stresses see Table III, and for design stresses see Table IV.

All members were designed according to Ostrup's Standard Specifications. (See SHEET 3.)

The following allowable units stresses were used:-

Tension........16000 pounds per sq. inch.

Compression....16000-70 l/r for main members.

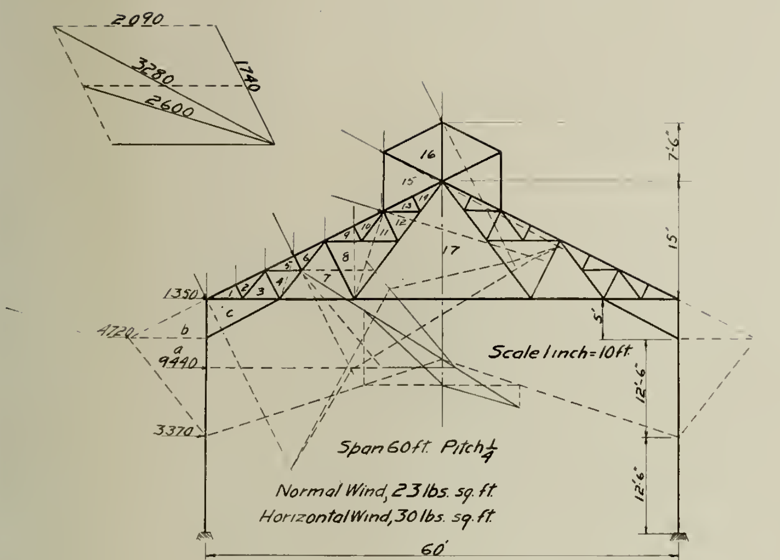
12000-70 l/r for eccentric stresses.

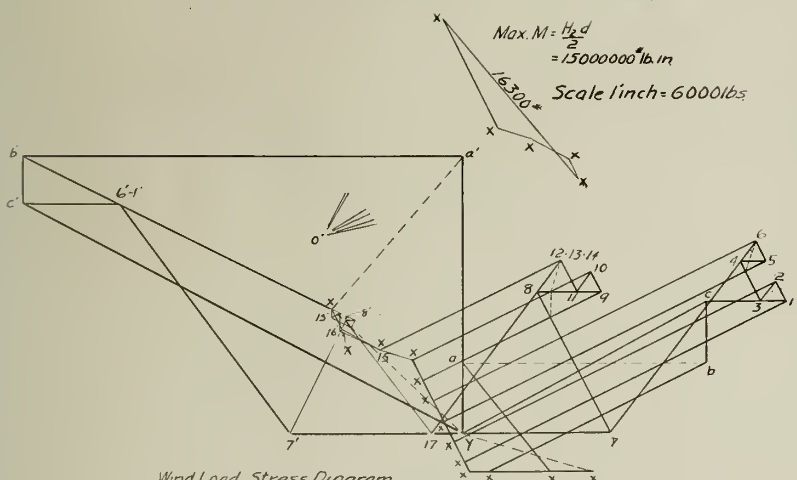
The sizes of the members, and the main features of the construction may be seen by referring to SHEET 3

The smallest angle used is a $2\frac{1}{2}$" x 2" x $\frac{1}{4}$", while the smallest angle used for main members is a $2\frac{1}{2}$" x $2\frac{1}{4}$" x $\frac{1}{4}$". The least thickness of gusset plate is 3/8-inch.

The roof purlins consist of 4-inch, $5\frac{1}{4}$-pound channels, held in place by clips.

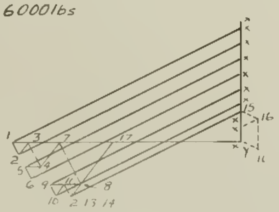
The columns were designed to carry a 5-ton overhead electric crane. The computations for the de-





Wind Load Stress Diagram
Scale 1inch = 6000lbs

Truss Member	Dead Load Stress	Snow Load Stress Min.	Snow Load Stress Max.	Wind Load Stress	Maximum Stress
a-y	- 6150	- 6150	-12300	- 5140	-18450
b-c	- 6150	- 6150	-12300	+ 4700	-18450
c-y				+21000	
x-1	-13000	-13000	-26000	-19400	-45400
x-2	-12600	-12600	-25200	-19400	-44600
x-5	-12200	-12200	-24400	-19400	-43800
x-6	-11900	-11900	-23800	-19400	-43200
x-9	-10800	-10800	-21600	-15100	-36700
x-10	-10500	-10500	-21000	-15100	-36100
x-16	+ 900	+ 900	+ 1800	+ 100	+ 2700
x-16'	+ 900	+ 900	+ 1800	- 700	+ 2700
x-15'				- 600	
x-(10'-9')				- 2000	
x-(6'-1')				+18000	
y-7	+ 9200	+ 9200	+18400	+11200	+29600
y-17	+ 6500	9200	+13000	- 2400	+19500
y-7'				-13100	
(1-2),(5-6),(9-10)	- 700	- 700	- 1400	- 1740	- 3140
(2-3),(4-5),(10-11)	+ 800	+ 800	+ 1600	+ 1900	+ 3500
3-4	- 1400	- 1400	- 2800	- 3400	- 6200
11-12	- 700	- 700	- 1400	- 2700	- 4100
4-7	+ 1600	+ 1600	+ 3200	+16400	+19600
8-11	+ 800	+ 800	+ 1600	+ 3000	+ 4600
6-7	+ 2250	+ 2250	+ 4500	+18400	+22900
8-9	+ 1600	+ 1600	+ 3200	+ 4900	+ 8100
7-8	- 2350	- 2350	- 4700	-12100	-16800
8-17	+ 2650	+ 2650	+ 5300	-13500	+ 7950
(12-17),(14-17)	+ 3400	+ 3400	+ 6800	-16500	+ 10200
15-(13-14)	- 9600	- 9600	-19200	-15400	-34600
15-16	- 900	- 900	- 1800	- 3300	- 5100
16-16'	- 1500	- 1500	- 3000	- 1300	- 4500
15'-16'				- 700	
15'-(13'-14')				- 1700	
11'-12'				- 600	
8'-(11'-9')				+ 700	
8'-17				-10800	
7'-8'				+ 9600	
7'-(6'-1')				-21800	
c'-(3'-1')				+ 7300	
c'-y				-37700	
c'-b'				- 3600	
a'-y				-21200	
7'-y				-13100	



Dead Load Stress Diagram
Scale 1inch = 4000lbs

STRESS SHEET
FOR
TRANSVERSE BENT
IN
KILN - SHED

Date June 1913 Thesis Work

Drawn by - Hanser, M.R Sheet No. 2

TABLE OF STRESSES FOR KILN-SHED

Truss Member	Stress					
	Dead Load	Snow Load		Wind Load	Max.	Min.
		Min.	Max.			
a-Y	- 6150	- 6150	-12300	- 5140	-18450	- 6150
b-c	- 6150	- 6150	-12300	+ 4700	-18450	- 1450
c-Y				+21000	+21000	
X-1	-13000	-13000	-26000	-19400	-45400	-13000
X-2	-12600	-12600	-25300	-19400	-44600	-12600
X-5	-12200	-12200	-24400	-19400	-43800	-12200
X-6	-11900	-11900	-23800	-19400	-43200	-11900
X-9	-10800	-10800	-21600	-15100	-36700	-10800
X-LO	-10500	-10500	-21000	-15100	-36100	-10500
X-16	+ 900	+ 900	+ 1800	+ 100	+ 2700	+ 900
X-16'	+ 900	+ 900	+ 1800	- 700	+ 2700	+ 200
X-15'	+ 1000	+ 1000	+ 2000	- 600	+ 3000	+ 400
X-9'	-10800	-10800	-21600	- 2000	-31500	-10800
X-10'	-10500	-10500	-21000	- 2000	-32400	-10500
X-1'	-13000	-13000	-26000	+18000	-39000	+ 5000
X-6'	-11900	-11900	-23800	+18000	-35700	+ 6100
Y-7	+ 9200	+ 9200	+18400	+11200	-29600	+ 9200
Y-17	+ 6500	+ 6500	+13000	- 2400	+19500	+ 4100
Y-7'	+ 9200	+ 9200	+18400	-13100	+29600	- 3900
(1-2)(5-6) (9-10)	- 700	- 700	- 1400	- 1740	- 3140	- 700
(2-3)(4-5) (10-11)	+ 800	+ 800	+ 1600	+ 1900	+ 3500	- 800
3-4	- 1400	- 1400	- 2800	- 3400	- 6200	- 1400
11-12	- 700	- 700	- 1400	- 2700	- 4100	- 700
4-7	+ 1600	+ 1600	+ 3200	+16400	+19600	+ 1600
8-11	+ 800	+ 800	+ 1600	+ 3000	+ 4600	+ 800
6-7	+ 2250	+ 2250	+ 4500	+18400	+22900	+ 2250
8-9	+ 1600	+ 1600	+ 3200	+ 4900	+ 8100	+ 1600
7-8	- 2350	- 2350	- 4700	-12100	-16800	- 2350
8-17	+ 2650	+ 2650	+ 5300	-13500	+ 7950	-10850
(12-17), (14-17)	+ 3400	+ 3400	+ 6800	-16500	+10200	-13100
15-(13-14)	- 9600	- 9600	-19200	-15400	-34600	- 9600
15-16	- 900	- 900	- 1800	- 3300	- 5100	- 900
16-16'	- 1500	- 1500	- 3000	- 1300	- 4500	- 1500
15-16'	- 900	- 900	- 1800	- 700	- 2700	- 900
15'-(13-14)	9600	- 9600	-19200	- 1700	-28800	- 9600
11'-12'	- 700	- 700	- 1400	- 600	- 2100	- 700
8'-9'	+ 1600	+ 1600	+33200	+ 700	+ 4800	+ 1600
8'-11'	+ 800	+ 800	+ 1600	+ 700	+ 2400	+ 800
8'-17	+ 2650	+ 2650	+ 5300	-10800	+ 7950	- 8150
7'-8'	2350	- 2350	- 4700	+ 9600	- 7050	+ 7250
7'-4'	+ 1600	+ 1600	+ 3200	-21800	+ 4800	-20200

TABLE III

TABLE OF STRESSES.
(Continued)

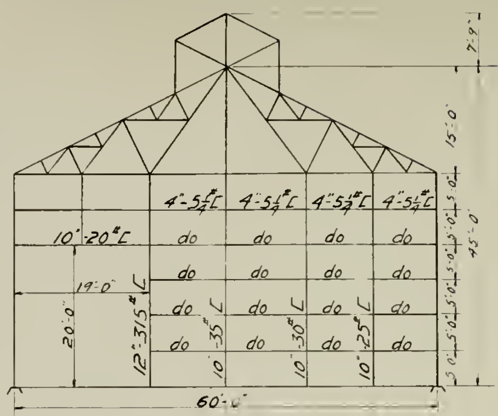
Truss Member	Stress					
	Dead Load	Snow Load Min.	Snow Load Max.	Wind Load	Max.	Min.
7'-6'	+ 2250	+ 2250	+ 4500	-21800	+ 6750	-19550
c'-1'	+11600	+11600	+23200	+ 7300	+34800	+11600
c'-3'	+10800	+10800	+21600	+ 7300	+32400	+10800
c'-Y				-37700	-37700	
c'-b'	- 6150	- 6150	-12300	- 3600	-18450	- 6150
a'-Y	- 6150	- 6150	-12300	-21200	-33500	- 6150
c-1	+11600	+11600	+23200	+ 4200	+34800	+11600
c-3	+10800	+10800	+21600	+ 6200	+32400	+10800
17'-12'	+ 3400	+ 3400	+ 6800	-10100	+10200	- 6700
17'-14'	+ 3400	+ 3400	+ 6800	-10100	+10200	- 6700

TABLE III (Cont.)

DESIGN STRESSES.

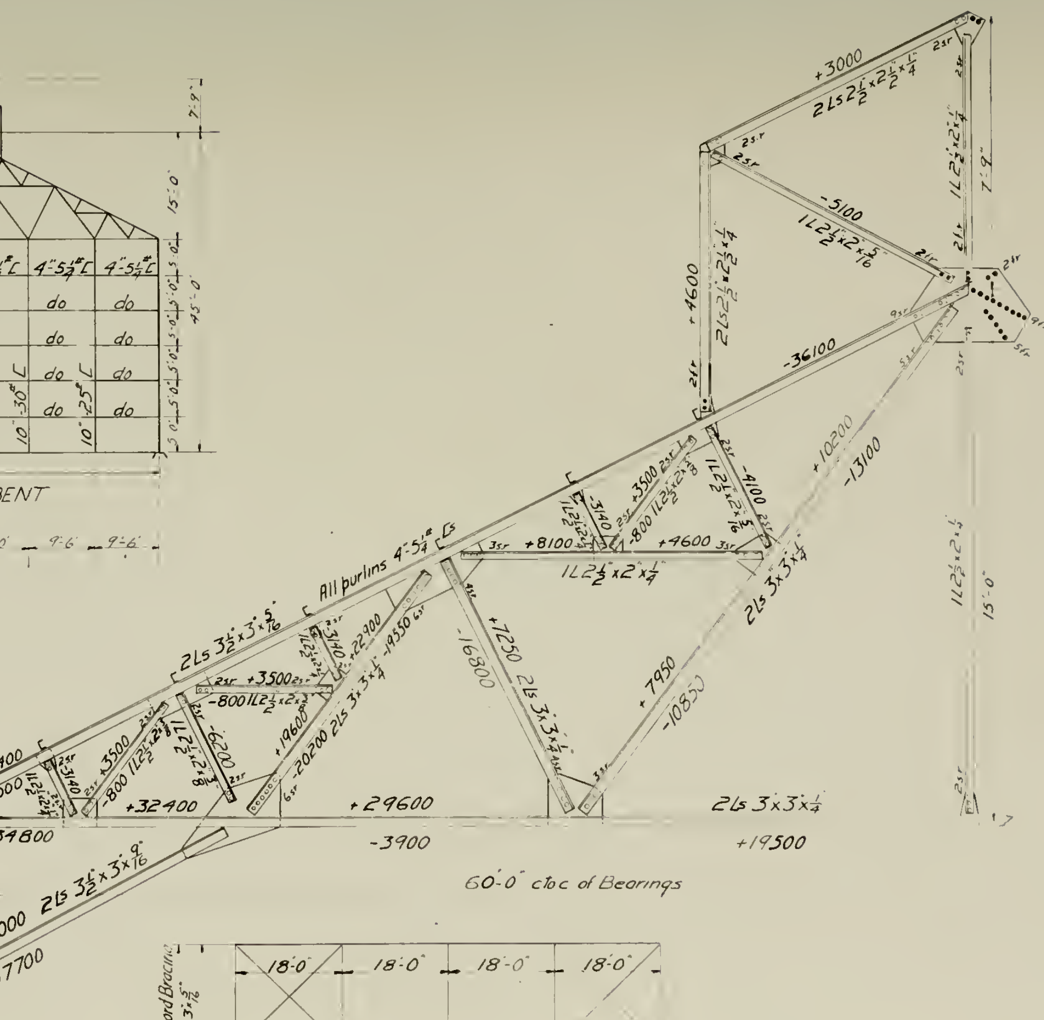
Truss Member	Stress: Dead Load Max.	Dead Load Min.	Wind Load Max.	Wind Load Min.	Design Max.	Design Min.
a-Y	-18400	- 6150	-33500	- 6150	-33500	-
b-c	-18400	- 1450	-18450	- 6150	-18450	
c-Y	+21000	- 0	-37700	- 0	+21000	-37700
X-1	-45400	-13000	-39000	+ 5000	-45400	+ 5000
X-6	-43200	-11900	-35700	+ 6100	-43200	+ 6100
X-9	-36700	-10800	-31500	-10800	-36700	
X-10	-36100	-10500	-32400	-10500	-36100	
X-15'	+ 3000	+ 400	------	------	+ 3000	
Y-7	+29600	+ 9200	+29600	- 3900	+29600	- 3900
Y-17	+19650	+ 4100	------	------	+19500	
(1-2)(5-6) (9-10)	- 3140	- 700	------	------	- 3140	
(2-3)(4-5) (10-11)	+ 3500	- 800	------	------	+ 3500	- 800
3-4	- 6200	- 1400	------	------	- 6200	
11-12	- 4100	- 700	- 2100	- 700	- 4100	
4-7	+19600	+ 1600	+ 4800	-20200	+19600	-20200
8-11	+ 4600	+ 800	+ 2400	+ 800	+ 4600	
6-7	+22900	+ 2250	+ 6750	-19550	+22900	-19550
8-9	+ 8100	+ 1600	+ 4800	+ 1600	+ 8100	
7-8	-16800	+ 1600	- 7050	+ 7250	-16800	+ 7250
8-17	+ 7950	-10850	+ 7950	- 8150	+ 7950	-10850
(12-17), (14-17)	+10200	-13100	+10200	- 6700	+10200	-13100
15-(13-14)	-34600	- 9600	-28800	- 9600	-34600	- 9600
15-16	- 5100	- 900	- 2700	- 900	- 5100	
16-16'	- 4500	- 1500	- 4500	- 1500	- 4500	
c'-1'	+34800	+11600	+34800	+11600	+34800	
c'-3'	+32400	+10800	+32400	+10800	+32400	
X-16	+ 2700	+ 900	+ 2700	+ 200	+ 2700	

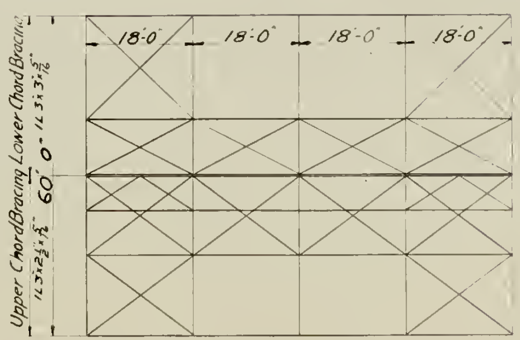
TABLE IV



PLAN OF END BENT

11'-0" 9'-6" 9'-6"





PLAN OF ROOF

DESIGN SHEET
FOR
FINK TRUSS
THESIS WORK

DATE - June - 1913 Scale ½in.=1ft

Drawn by M R Hansen SHEET No 3

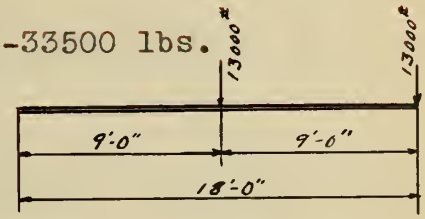
sign of columns are as follows:

Direct Load:-

Dead, snow, and wind--33500 lbs.

Reaction of Runway Girder:-

(See Fig. 5)



$18R - 18x13000 - 9x13000 - 9x720 = 0$

Fig. 5.

Let 4 angles 6"x3½"x11/16" and a16" x11/16"web plate be assumed and placed as shown in Plate III.

$$I(a-a) = 1520.2$$

$$r(a-a) = \sqrt{\frac{1520.2}{11+4x6.06}}$$

$$= 6.56$$

$$\text{Then } P = 16000 - \frac{70x30x12}{6.56}$$

$= 12160$ lbs. per sq.inch. (Allowable unit stress.)

The actual unit stress =

$$S = \frac{P}{A} - \frac{Mr'}{I - \frac{Pl^2}{Ec}}$$

The bending moment due to wind = 1500000 lb.inches.

The reaction due to runway girder = 12300 lbs.

The moment due to this reaction = 12300(8.125+8)

= 198200 lb.inches.

Double for Imp. 2x198200 = 396400 lb.inches.

Total M = 1896400 lb.inches.

$$\text{Then } S = \frac{33500\ (2x12300)}{11 + 4x6.06} + \frac{1896400 \ x \ 8.125}{1520 - \frac{(11500+2x12300)129000}{32x29000000}}$$

$= 1650 + 10130$

$= 11780$ lbs. per sq. inch.

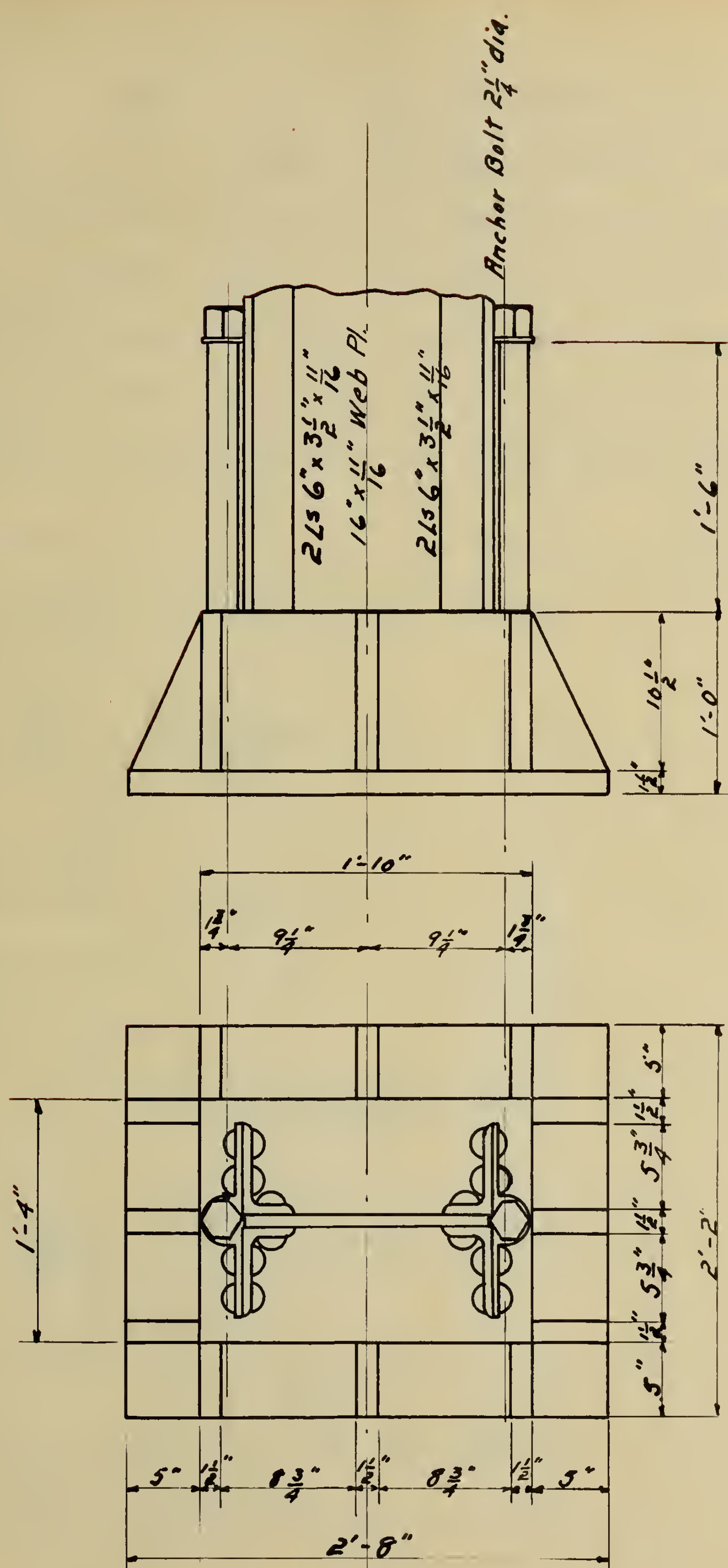

Anchor Bolt 2¼" dia.
2∠s 6" x 3½" x 11/16"
16" x 11/16" Web Pl.
2∠s 6" x 3½" x 11/16"
1'-6"
10½"
1'-0"
1½"
1'-10"
1¾"
9¼"
9¼"
1¾"
1'-4"
5"
1½"
5¾"
1½"
5¾"
1½"
5"
2'-2"
5"
1½"
8¾"
1½"
8¾"
1½"
5"
2'-8"

PLATE III

The base was designed to bear on a concrete slab of 1: 2: 4 mixture, having a maximum stress of 400 pounds per sq. inch. In obtaining the pressure on the extreme edge of the base the direct load due to dead, wind, snow, and crane loads, as well as the overturning effect due to the wind on the side of the building was considered. The computations follow:-

Dimensions of base---Top 16"x22"; base 26"x32".

S = pressure on extreme edge of base

$$= \frac{P}{A} + \frac{Mc}{I}$$

$$= \frac{45800}{26x32} + \frac{1500000x16}{\frac{26x32^3}{12}}$$

$$= 55 + 338$$

= 393 lbs. per sq. inch.

Anchor Bolts:-

$$2Ta + Pa - \frac{Hd}{2} = 0$$

$$T = \frac{-45800x9.25 + 1500000}{18.5}$$

= 58200 lbs.

$$\frac{52800}{20000} = 2.9 \text{ sq. inches required.}$$

$$\frac{\pi d^2}{2} = 29$$

$$d = 1.92 \text{ inches}$$

A $2\frac{1}{4}$-inch anchor bolt will be used.

(For detail see Plate III)

The tracks upon which the overhead crane runs extend the entire length of the kiln-shed, two feet above the point allowed for the easy operation of the brick-setting machine.

A short description of the setting machine will here be given. This machine is made of steel and is provided with a number of heavy, prehensile fingers, which enter the spaces left between the bottom rows of brick, as stacked on the dryer cars. Since each stack, consisting of 840 bricks, has been built on a uniform plan, it is easy for the operator to run the setter into the spaces. Each finger is provided with pressure plates, automatically operated. As soon as the weight of the load of bricks rests upon the setting machine the grip plates are automatically closed on the bottom row of bricks with just enough pressure to keep them from falling. When the stack is lowered into position the weight of the load is removed and the pressure is automatically released by the grip-plates.

This brick-setting machine takes the place of 36 setters and double that number of tossers and helpers. Thus one can readily understand what a great boon this machine will be to brick manufacturing.

INSTALLATION OF BOILERS, ENGINES, AND MACHINERY

Boilers

Five units of Babcock-Wilcox Water-Tube Boilers,

190 H. P. each, are located as shown in the general plan. (See SHEET I.) A Jones Stoker is used to fire all of the boilers.

Engines

The power for the plant is furnished by a 26 x 44-inch, Hamilton-Corliss 900 H. P., double eccentric, compound engine, located as shown on SHEET I. The electric current for lighting, for operating electric trains, for transfer cars, and for the return car system, is furnished by a 75-kilowatt Fort Wayne generator, 220 volts direct current, which is directly connected with an Erie Iron Works high-speed engine. The location of this equipment is shown in the general plan. (See SHEET I.)

Machinery

The clay-machinery installed is that made by the Chambers Brothers Co., of Philadelphia, Pa.

Granulator

One of the most valuable features of the granulator is that it saves labor and feeding, and insures a uniform supply of material to the subsequent machinery. The clay is received in carload lots. The large lumps of clay are shaved into smaller pieces and the different strata of sand and clay are partially mixed. The machine is shown in Fig. 6, the discharge end being

toward the end farthest from the gearing. The length of the frame is 19 feet, the width is 5½ feet, and the height from bottom of frame angle to top of hopper is 3½ feet. It weighs about 15000 pounds.

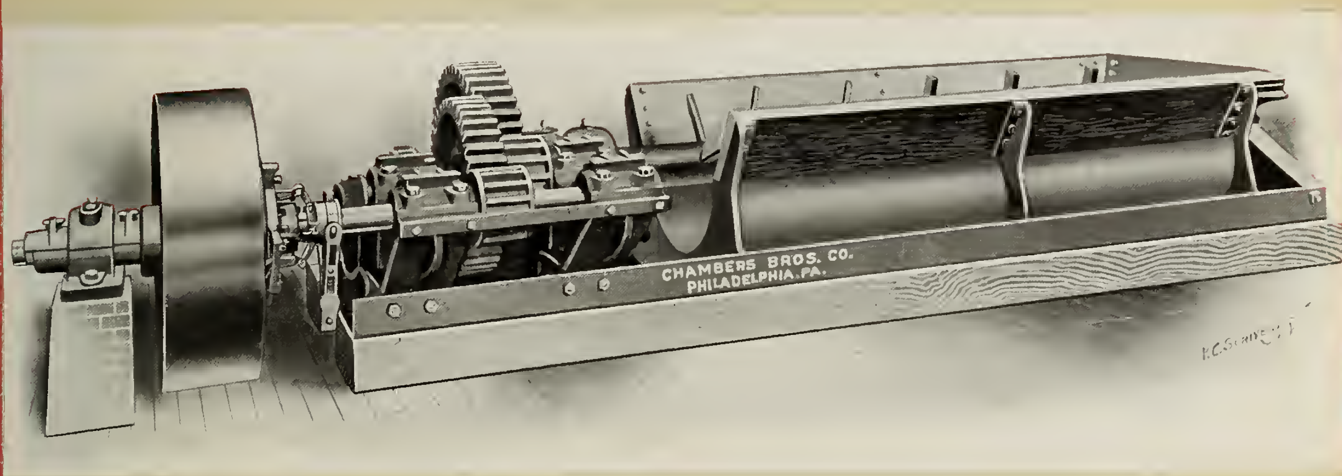


Fig. 6.

Crushing-Rolls

From the granulator, the clay is conveyed downward into the crushing-rolls. The type used is the single, conical roll with one end of the roll-shafts elevated. (See Fig. 7.) This leaves the upper faces of the rolls level, thus facilitating the discharge of stones.

Conveyor

From the crushing mills the clay is conveyed and elevated to the Pug-Mill. The type of conveyor is

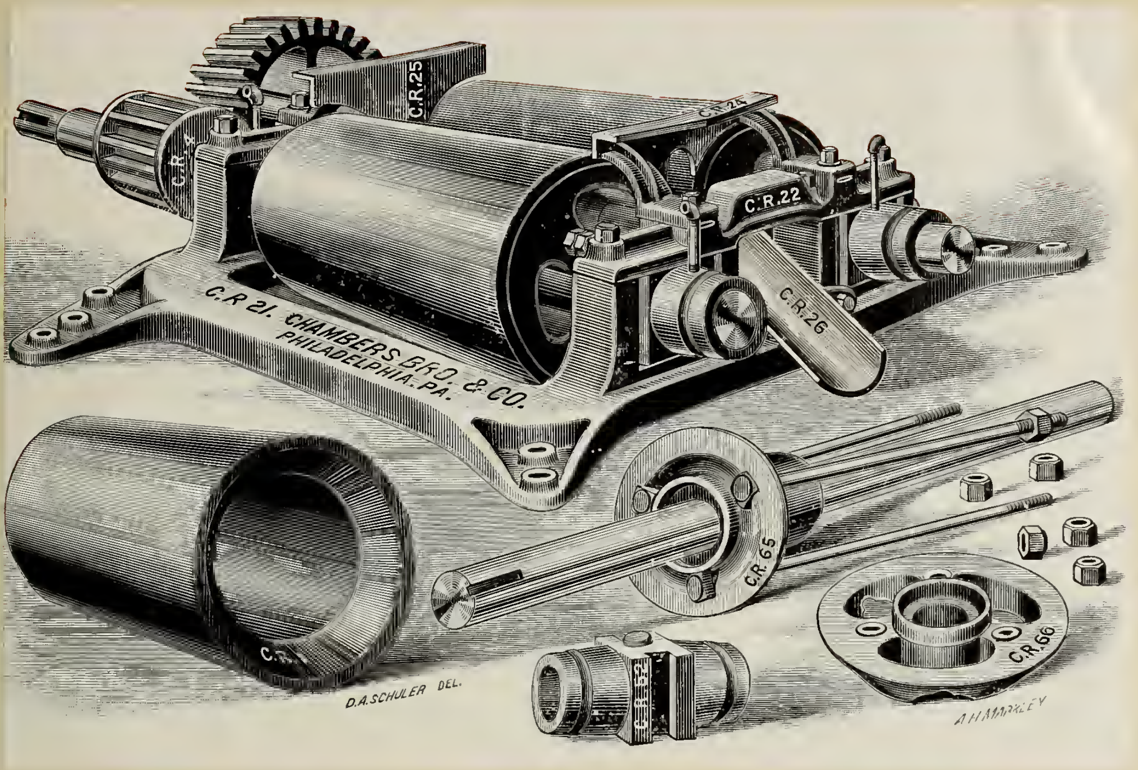
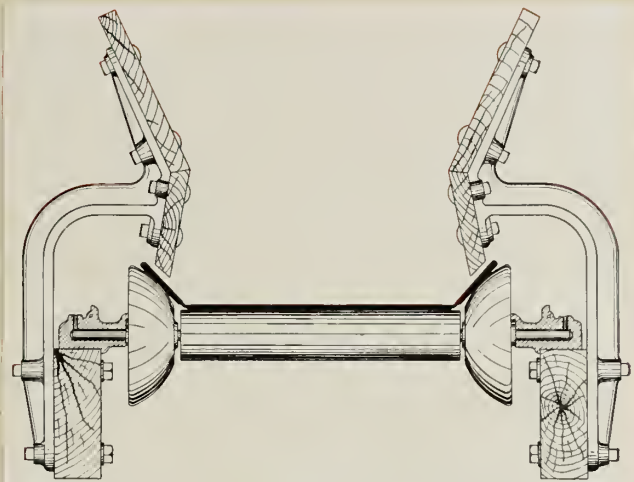


Fig. 7.

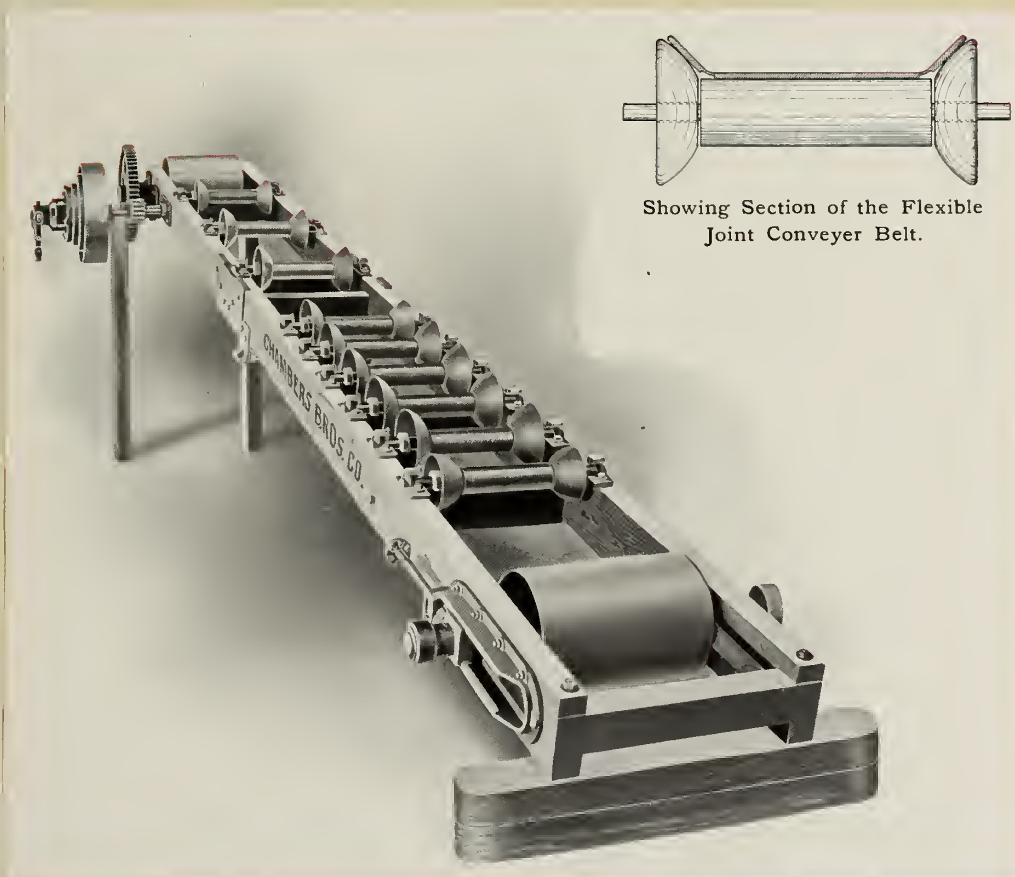
shown in Fig. 8. This type has an advantage over the older form in that the belt conforms to the flat trough shape required by the rollers, thus dispensing with the usual side-boards extending the entire length of the elevator. The boards were designed to prevent spilling, but are never very efficient. They are the cause of much wear on the belt.

Pug-Mill

The pug-mill is used to mix the clay with water, delivering a thoroughly mixed, well-pugged mass, which is uniform in quality. The entire length of the



Showing Arrangement of Feed-Hopper Over Lower End of Flexible Joint Conveyer.



Showing Section of the Flexible Joint Conveyer Belt.

Fig. 8.

mill is 19 feet, and its width is 4 feet. Its weight is 9200 pounds. A view of the machine is shown in Fig. 9

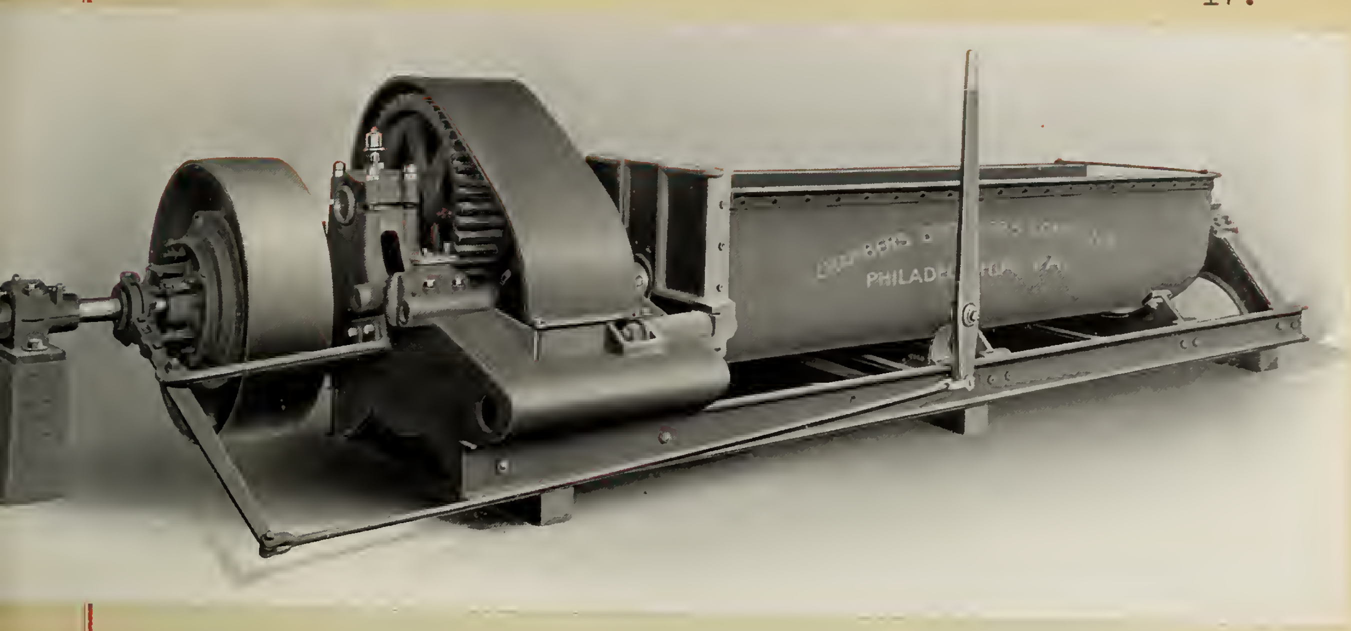


Fig. 9.

End-Cut Brick-Machine

From the pug-mill the thoroughly mixed clay is dropped into the hopper of the Chambers No. 7 end-cut brick-machine. (See Fig. 11).

DISTRIBUTION OF ROLLING STOCK ABOUT YARD

The dryer-car used is shown in Fig. 10).

Fig. 10.

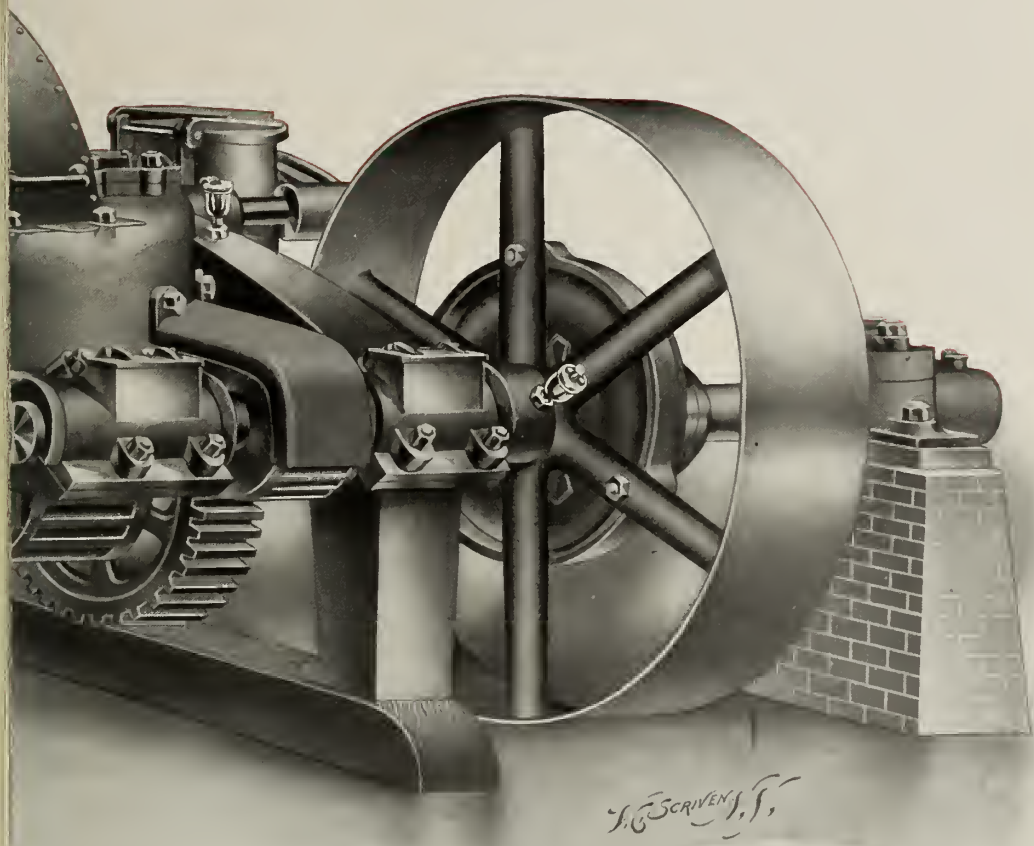
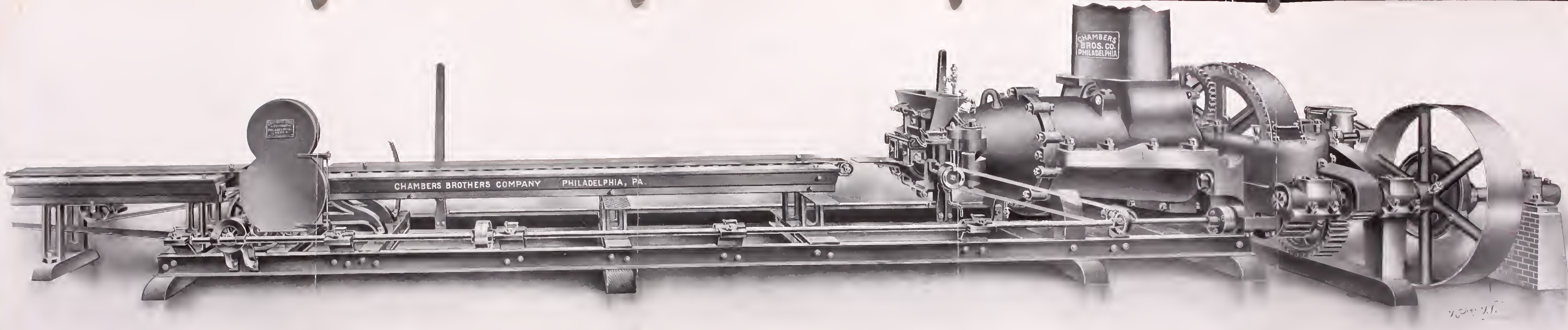


Fig. 11.



THE CHAMBERS No. 7 END-CUT BRICK MACHINE with the improved Automatic End-Cutter. Weight about ten tons. Floor space occupied is about 52 feet in length by 8 feet in width at gear end. Automatically sands four sides of the clay bar. Normal output 6,000 bricks per hour. Under favorable conditions this has been increased to as many as 25,000 bricks per hour.

The normal speed for driving pulleys on this machine is 220 revs. per minute. Some of our customers in the city of Chicago run the machine at about 400 revs. per minute, and when such high speeds are contemplated, the machine should be constructed under special specifications as to shafts, gears, etc., particulars of which will be given in contracts.

CHAMBERS BROTHERS COMPANY, PHILADELPHIA.

The trucks are built for a $22\frac{1}{2}$-inch guage track. The length of body is 92 inches, and the truck is designed to carry 840 bricks.

The transfer cars are electrically operated, and are built to carry three dryer-cars. The trucks of a car without a motor are shown in Fig. 12.

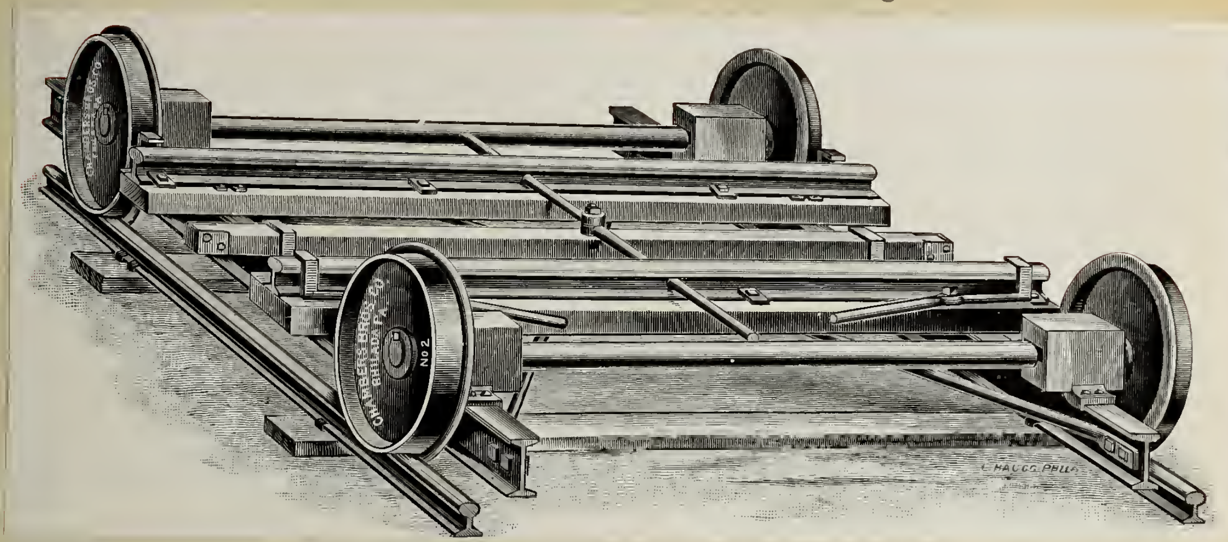


Fig. 12.

SHEET I, with attached legend, gives a good idea of the location of the tracks. The tracks about the plant have been laid so that after the cars are loaded at the machine every move is either on a level or on a slight incline directly toward the kiln-shed. This arrangement permits of a maximum output from a minimum effort. The loading tracks were laid parallel to the off-carrying belt, and just far enough from it to admit a workman. This track has a 22-inch gauge.

The transfer track, which is built across the dryer at both ends, has a standard gauge and is built to carry the electric transfer-car. Portable tracks are laid

down through the kiln-shed so that the dryer-cars laden with dried bricks may be transferred to any part of the building. A narrow-gauge track has been provided for the disposal of empty dryer-cars.

BURNING SYSTEM

Oil is used for fuel in burning the bricks. The Kirkwood No. 4 oil burner, manufactured by Tate-Jones & Co., is used. The oil is pumped from the two 25000-gallon underground tanks into a gravity tank. (See T and U, SHEET I). A pressure head of forty feet is maintained, thus giving the required pressure at the end of the burners. The burner proper is shown in Fig. 13.

Fig. 13.

Plate IV shows the system used in laying the pipe for the burning of 25 arches of brick.

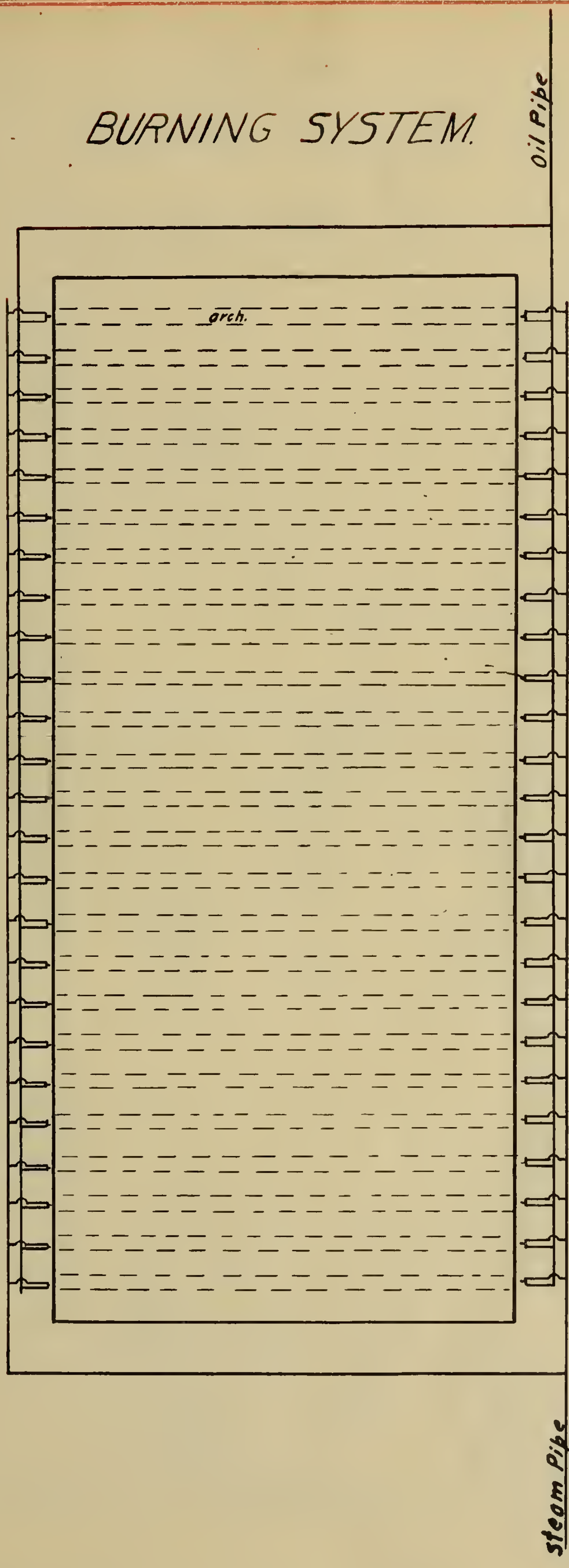


PLATE IV

COST DATA

The following are the cost data for this plant ;

Boiler Room

	Cost per Cu. Yd.	Total Cost
WALLS-		
Labor-		
Masons @ $.60 per hr.	$2.80	
Helpers @ $.17½ per hr.	.93	
Carp'trs @ $.21¼ per hr.	.39	
Handling Materials	.60	
Total	4.00	$ 1250.00
Materials-		
Brick @ $5.08 per M	$2.33	
Cement .22 bbl.@ $2.00-	.44	
Sand .26 cu. yd.@ $.50-	.13	
Lime 1 bushel @ $.20	.20	
Hauling on above	.40	
Total	3.50	1092.00
TRUSSES-		
Erection @ $10.00 per ton		160.00
Freight @ $.18 per 100 lbs. (Pitts.)		57.60
Steel @ 63.60 per ton (Includes raw material, millwork, shop work, and painting.		1020.00
ROOF-		
Labor at $.21¼ per hr. - Materials @ $30.00 per 100 sq. ft.		2625.00

FLOOR-	Total Cost
Labor @ $4.00 per cu. yd.----------	$ 667.00
Materials @ $2.40 per cu. yd.-----	383.00

Machine Room

WALLS-	
Labor @ $4.00 per cu. yd. of masonry--	1068.00
Materials @ $3.50 per cu. yd. of masonry------- ----------------	828.40
TRUSSES-	
Erection @ $10.00 per ton---------	210.45
Freight @ $.18 per 100 lbs.------	75.70
Steel @ $63.60 per ton------------	1338.60
ROOF-	
Labor @ $.22¼ per hr.------------- Materials @ $30.00 per 100 sq. ft.	2280.75

Dryers

WALLS-	
Labor @ $4.00 per cu. yd. of masonry--	1306.80
Materials @ $3.50 per cu. yd. of masonry------------------------	1012.00
ROOF-	
Labor @ $.50 per hr. (one man lays 3 squares per 10 hr. day)---------	160.00
Materials-	
Lumber @ $30.00 per M-----------	2640.00
Granite Paper @ $3.50 per roll(1 yd)--	560.00

	Total Cost
COLUMNS-	
Old boiler flues (includes price of setting)----------------	$ 290.00
HEATING SYSTEM-	
Includes pipe, track, floor and all other interior equipment.-----	4320.00

Kiln-Shed

WALLS AND ROOF COVERING-	
Labor @ $.50 per hr.--------------	900.00
Materials------------------------	4528.00
TRUSSES-	
Erection @ $10.00 per ton---------	1500.00
Freight @ $.18 per 100 lbs.-------	540.00
Steel @ $63.60 per ton------------	8900.00
COLUMNS-	
112 columns and column bases @ $20.60	2307.20
3 traveling cranes @ $1000.00-----	3000.00
Erection @ $3.00 per ton of steel work------------------ ----------	250.00
Concrete in place for column bases	600.00
MISCELLANEOUS-	
5 Babcock-Wilcox boilers (in place) @ $3000.00----------------------	15000.00
5 Jones Stokers @ $1000.00--------	5000.00
Engines-	
26x44-inch Hamilton-Corliss-----	15000.00
Erie Iron Works high-speed engine	6000.00

	Total Cost
Generator, Ft. Wayne, 220 volts	$1500.00
Machinery:-	
Granulator-----------	600.00
Crushing-Rolls-------	300.00
Conveyor-------------	900.00
Pug-Mill-------------	700.00
End-cut brick-machine	9000.00
Rolling Stock:-	
Dryer-cars, 600 @ $6.00	3600.00
Transfer-Cars. 3 @ 600.	1800.00
Track--1200 ft. of 22½-inch gauge & 2500 ft. of standard gauge 60#----	1500.00
2 underground tanks(concrete @ $17.50 per cu. yd.)-------------	1140.00
2 covers for above @ $80.00-----	160.00
1 elevated tank (Cap. 10000 gal.)	600.00
1 oil pump---------------------	450.00
2 motors-----------------------	1200.00
Belting @ $2.75 per ft. 12 in. wide----------------------------	1150.00
Shafting (including bearings)---	1000.00
Total Cost	$112480.50